PB86-156825

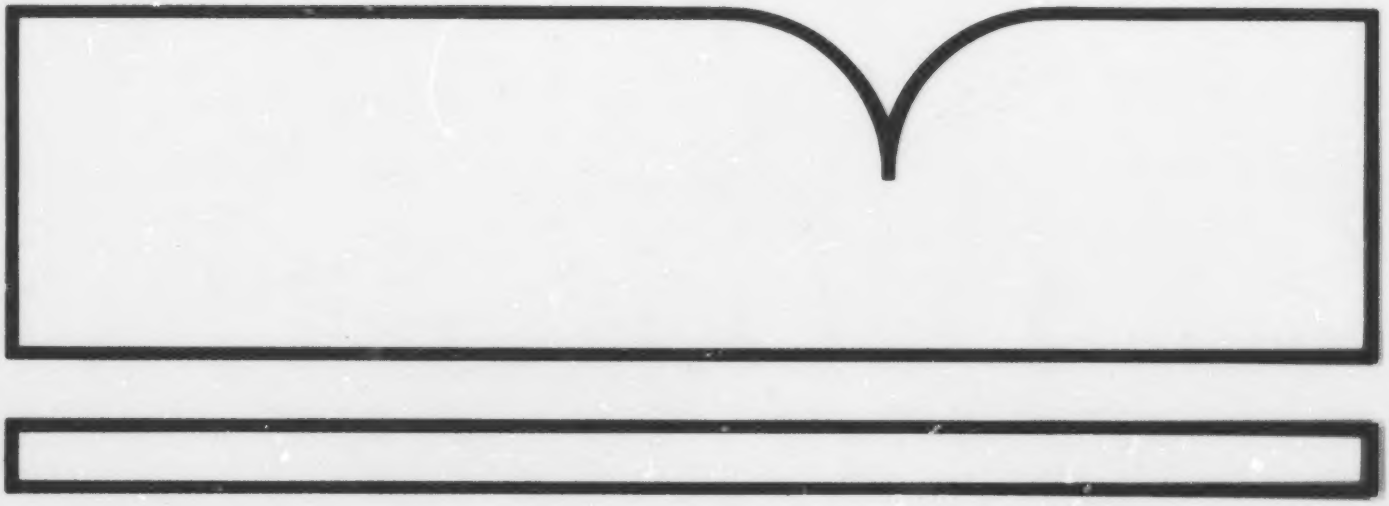
Solvent Extraction: Summary Report for Technical Support in Development of a Revised Ozone State Implementation Plan for Memphis, Tennessee

Pacific Environmental Services, Inc.
Durham, NC

Prepared for

Environmental Protection Agency, Atlanta, GA

Jun 85



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REPORT

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PACIFIC ENVIRONMENTAL SERVICES, INC.

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SPRINGFIELD, VA. 22161

SOLVENT EXTRACTION

SUMMARY REPORT

FOR

TECHNICAL SUPPORT IN DEVELOPMENT
OF A REVISED OZONE STATE
IMPLEMENTATION PLAN FOR
MEMPHIS, TENNESSEE

Mr. Ron McHenry - Project Officer
U.S. Environmental Protection Agency
Region IV
EPA Contract No. 68-02-3887
Assignment No. 13

PACIFIC ENVIRONMENTAL SERVICES, INC.
1905 Chapel Hill Road
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The document presents information on emissions of volatile organic compounds (VOC) from solvent extraction processing facilities in Shelby County, Tennessee. Information is presented on the soybean and cottonseed oil extraction industry, emissions from solvent extraction plants, emission control techniques, and the costs of reducing emissions. Sources of information include: an inspection at a soybean processing plant, a background document prepared by the Illinois Pollution Control Board, EPA publications, literature from the National Soybean Producers Association (NSPA) and National Cottonseed Products Association (NCPA), and discussions with industry representatives. The control measures described in the document represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing soybean and cottonseed processing plants. Reasonably available control technology for solvent extraction plants consists of efficient operation of the mineral oil scrubber and desolventizer-toaster, and good engineering practices (e.g., repair of leaking equipment).

KEYWORDS: *Solvent extraction, *Air pollution control, *Volatile organic compounds, *State implementation plan, *Emission factors.

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DISCLAIMER

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1.0 INTRODUCTION AND SUMMARY

This document presents information on emissions of volatile organic compounds (VOC) from solvent extraction processing facilities in Shelby County, Tennessee. Information is presented on the soybean and cottonseed oil extraction industry, emissions from solvent extraction plants, emission control techniques, and the costs of reducing emissions. Sources of information include: an inspection at a soybean processing plant, a background document prepared by the Illinois Pollution Control Board, EPA publications, literature from the National Soybean Producers Association (NSPA) and National Cottonseed Products Association (NCPA), and discussions with industry representatives.

The control measures described in this document represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing soybean and cottonseed processing plants. Reasonably available control technology is defined as the lowest emission limit that a particular source is capable of achieving by application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories. It is not intended that extensive research and development be conducted before a given control technology can be applied to the source. However, short-term evaluation programs are considered an appropriate technology forcing aspect of RACT.

Reasonably available control technology for solvent extraction plants consists of efficient operation of the mineral oil scrubber and desolventizer-toaster, and good engineering practices (e.g., repair of leaking equipment). RACT was found to be in place in Shelby County, Tennessee, in a solvent extraction plant. The demonstrated ability of an existing solvent extraction plant in Shelby County and the emission limit proposed by the Illinois Pollution Control Board form the basis for determining RACT. Efficient operation of the mineral oil scrubber and desolventizer-toaster is judged to be emission limits of (1) 0.0026 kg VOC per kg of soybean or cottonseed processed for conventional plants (e.g., those plants extracting meal for non-human consumption) and (2) 0.0052 kg VOC per kg of soybean or cottonseed processed for specialty plants (e.g., plants extracting meal for human consumption).

2.0 PROCESSES AND POLLUTANT EMISSIONS

2.1 INDUSTRY DESCRIPTION

The domestic soybean and cottonseed industries are similarly structured with a few companies dominating the market. Soybean meal and oil markets are dominated by two companies: Cargill, Inc. of Minneapolis, Minnesota, and Archer-Daniels, Midland Company (ADM) of Decatur, Illinois. The ten largest companies, by volume of soybean crush, produce nearly 80 percent of the soybean oil and meal in the United States.[1] The dominating cottonseed processors include the several California Cooperative producers and large processors such as Archer-Daniels Midland, and the Anderson Clayton Company.[2]

There are a number of end products that are obtained from soybeans, but the three major products are livestock feed, soybean oil (used for making margarine or salad oil) and edible protein for human consumption. Although cottonseed meal is high in protein, it is used primarily as fertilizer or as feed for ruminant livestock. The use of cottonseed meal as a source of protein for humans is limited by the presence of high levels of free gossypol in glanded cotton seed flakes. Gossypol is a substance in glanded cottonseeds that causes discoloration of poultry eggs and skin, and at higher concentrations, may be harmful to the chicken. This document focuses on solvent extraction plants and solvent extraction processes designed to produce soybean and cottonseed oil and meal for livestock.

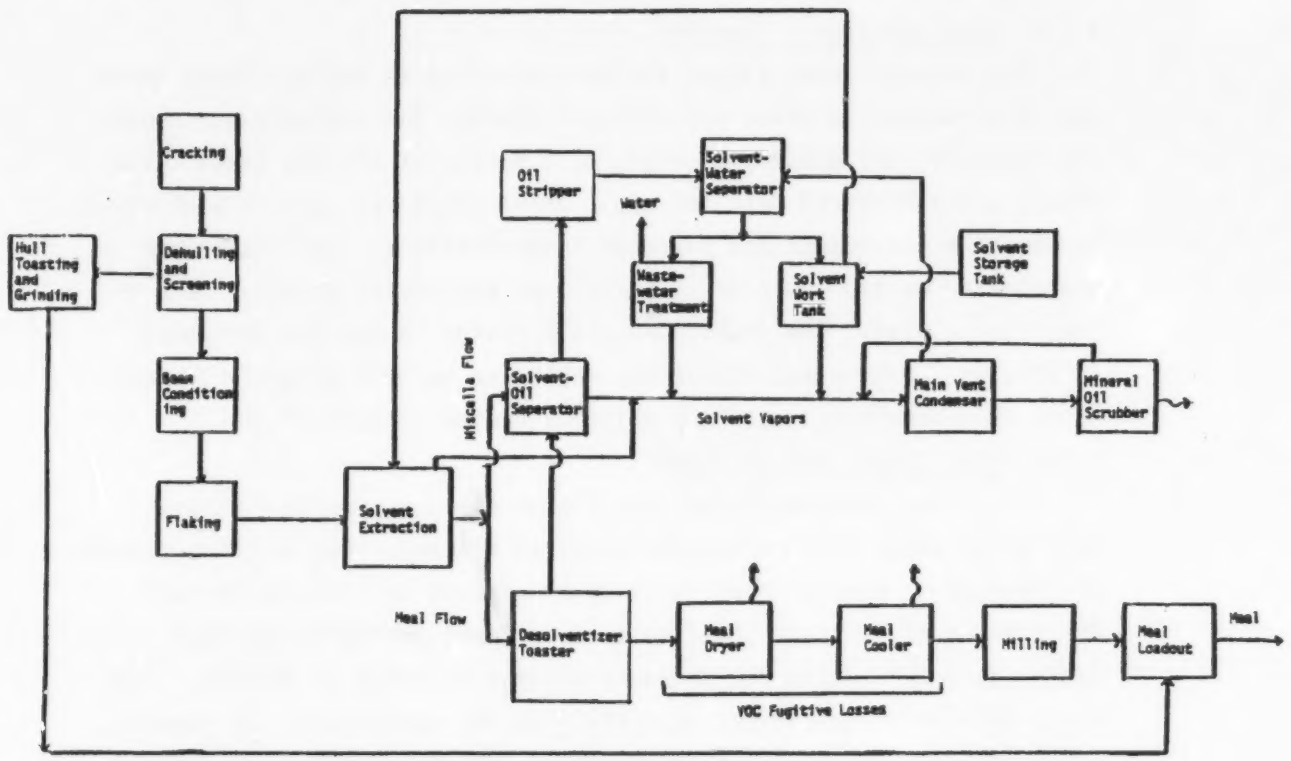
Two solvent extraction manufacturers are located in Shelby County, Tennessee. One plant, Cargill, Inc., processes soybeans, and the other, Southern Cotton Oil, predominantly processes cottonseeds and some soybeans. The Cargill facility consists of two soybean processing lines, with one slightly larger than the other. A representative of Cargill stated that, in general, the industry is running at 65 percent of design capacity. Additionally, Cargill does not operate the plants as extensively in the summer as the fall since plant operations are less efficient in hot weather and economic conditions are also less favorable.

2.2 PROCESS DESCRIPTION

This section presents a general description for processes that have a significant potential for VOC emissions, resulting from hexane extraction of soybean and cottonseed flakes. The same solvent extraction process can be used for both soybeans and cottonseed.[3,4] Cottonseed oil can also be extracted using screw-press or prepress methods. These methods are not discussed in this report. Detailed process information is considered confidential by the processing plants, therefore, descriptions reflect a typical processing plant. A typical processing plant contains a number of unit operations that are performed on the soybean or cottonseed feed (See Figure 2-1). To facilitate discussion, each unit operation will be discussed separately.

2.2.1 Solvent Extraction[5]

Solvent extraction for the oil and meal processing industry is generally done in a batch process. Soybean or cottonseed flakes, processed from soybeans or cottonseeds, are conveyed to an extractor into which hexane is pumped. The rotary cell extractor consists of a series of baskets that rotate continuously on a horizontal plane to mix the incoming flakes and hexane. The flakes become saturated with hexane. The hexane strips oil contained in the flakes. The resulting oil and solvent mixture (miscella) is recovered from the soybean or cottonseed meal. The flow of hexane and flakes are counter current to ensure maximum extraction. The miscella drains through perforated floors of each cell to lower compartments where it is pumped counter to the rotating baskets. When the miscella is completely drained, the basket floor drops and the wet flakes are dumped into a hopper and transferred to a vapor tight conveyor to the desolventizer-toaster (D-T). The mixture can be viewed through several site glasses in the extractor. The hexane vapor concentration is monitored at these points. Extractor throughput ranges between 200 and 300 tons of soybeans or cottonseeds crushed per day, and extractor residence time ranges between 30 minutes and 2 hours.[5] The extractor is vented to the main vent condenser (see Figure 2-1). After extraction, the effluent consists of two streams. The wet flakes are conveyed to the D-T for further processing, and the miscella is separated further in the



Direct venting of emissions to atmosphere

NOTE: Schematic assumes no solvent lost in wastewater or mineral oil.

Figure 2-1. Schematic of a Soybean Processing Plant[5]

solvent oil separator. Solvent vapors are ducted to the main vent condenser.

2.2.2 Desolventizer - Toaster[5]

The solvent laden flakes are desolventized in the D-T using steam and then toasted to drive off residual solvent for recovery and reuse. The desolventizer-toaster consists of a series of stacked trays. The flakes are introduced into the upper trays which are sprayed with steam to vaporize the hexane and increase flake moisture. The flakes are transferred to the lower trays where they are heated to about 70°C to toast the flakes. The flakes generally reside in the D-T for about 45 minutes. Cottonseed flakes may reside in the D-T slightly longer, since they generally contain a slightly greater amount of oil.

2.2.3 Meal Drying and Cooling[5]

Following desolventizing, the flakes are conveyed to a rotary meal dryer where they reside for about 15 minutes. The moisture content of the meal is reduced from about 19-20 percent to 13 or 14 percent. The dried meal is transported to a cooler that decreases the meal temperature and lowers the moisture content to about 12 percent. The dryer and cooler are vented separately to the atmosphere. In general, approximately 50 percent of the incoming solvent is exhausted through these vents. Following drying and cooling, the meal is conveyed to a preparation plant where it undergoes screening and grinding. The finished, ground meal is conveyed to a storage or bulk transport system. Fugitive VOC losses may occur between the dryer and cooler, and between the cooler and the grinding plant.

2.2.4 Solvent-Oil Separation[5]

The solvent-oil mixture (micella) from the D-T is filtered to remove suspended solids and then separated into oil and solvent by a two-stage evaporator. The solvent removal efficiency is approximately 95 percent for this process. After evaporation, the micella flows to an oil stripper which removes additional solvent by flaking and low-pressure steam stripping. The stripped oil is cooled and collected for off-site refining, while the solvent-water vapor is condensed in a solvent water separator. Hexane is routed to a solvent work tank and recycled, while water from the separator goes to wastewater treatment.

2.2.5 Solvent Recovery[5]

Solvent vapors from the extractor, solvent-oil separator, solvent water separator, solvent work tank, and other indirect sources are transported by a vent blower to a series of indirect, water cooled condensers and to the main vent condenser where solvent vapors are cooled. The condensers are all vented to the mineral oil scrubber system. This system reduces the amount of hexane escaping to the atmosphere and consists of a mineral oil stripper, an absorption column, and mineral oil coolers and heaters. Figure 2-2 presents a diagram of a mineral oil scrubber. Cooled mineral oil flows counter current to solvent vapors to absorb approximately 95 to 98 percent of the hexane. The contaminated mineral oil in the absorption column is stripped with steam, and the resulting clean oil is cooled and recycled to the scrubber. The vapors are condensed and recycled to the working solvent tank. Uncontrolled hexane emissions are discharged from the absorption column and vented through the roof through a final exhaust vent. This vent is equipped with a flame arrestor to prevent fires.

2.3 SOURCES OF VOC EMISSIONS

For the typical processing plant, there are four main sources of VOC emissions: (1) the main vent of the mineral oil scrubber (MOS), (2) the meal dryer vent, (3) the meal cooler vent, and (4) fugitive losses (see Table 2-1). Generally, none of the vents are controlled for VOC emissions. The MOS does in fact reduce VOC emissions significantly from the main vent condenser, but the main purpose of the MOS is to recover hexane for process efficiency. Hence, an MOS is considered a part of the plant processing equipment. Similarly, emissions from the meal dryer and meal cooler are dependent upon the efficiency of the desolventizer-toaster. Figure 2-3 is a schematic representation of model soybean or cottonseed processing plant emissions.

It should be noted that these figures represent averages and on a particular day, the actual emissions could be quite different. In general, manufacturers maintain that a minimum of 180-day "rolling average" is necessary for accurate VOC estimations. The term "rolling average" is a method of averaging solvent loss over a period of time when the plant is operating and shut down. This technique helps account for days when the emissions are very high (i.e., plant shutdown

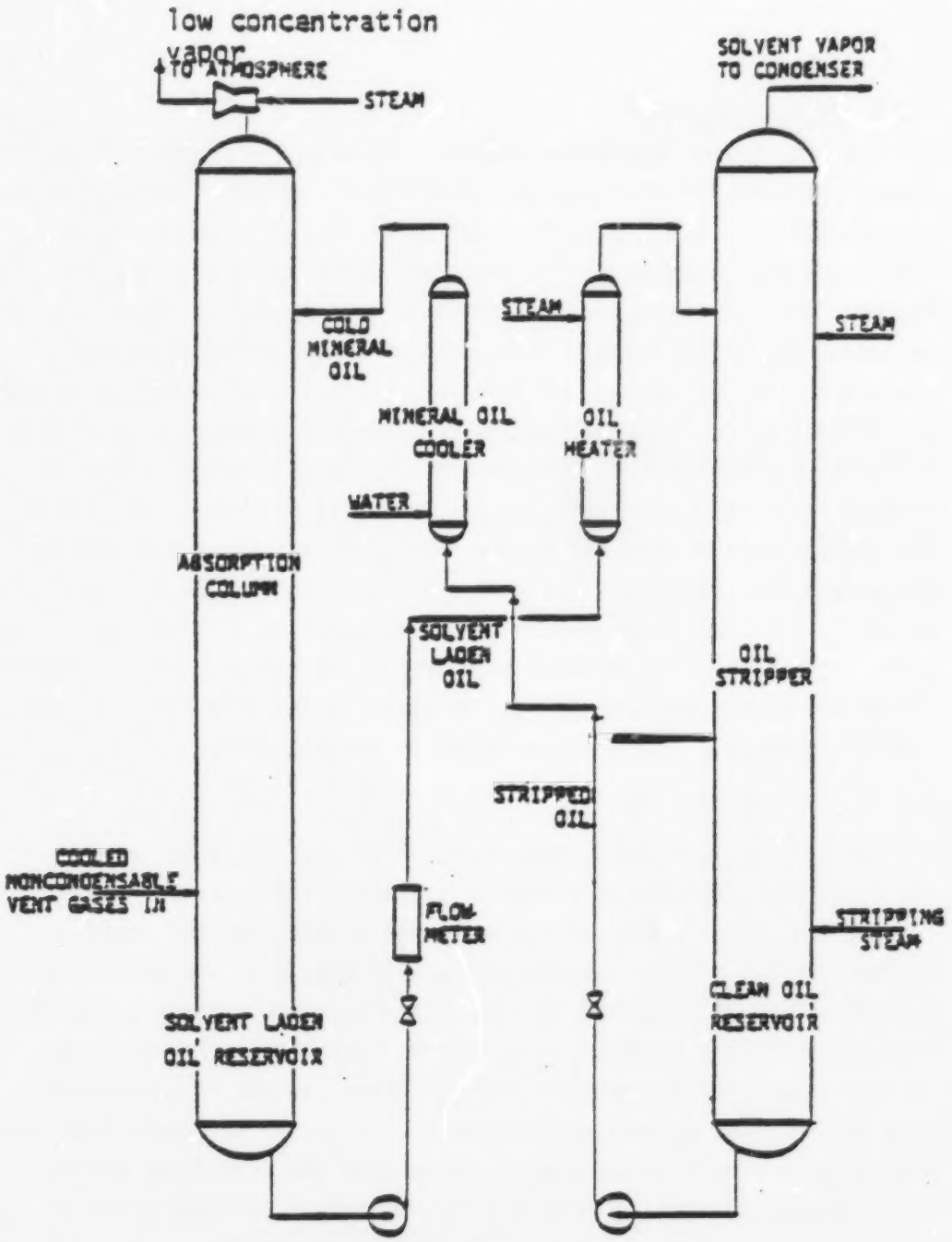


Figure 2-2. Schematic Diagram of a Mineral Oil Scrubber.[5]

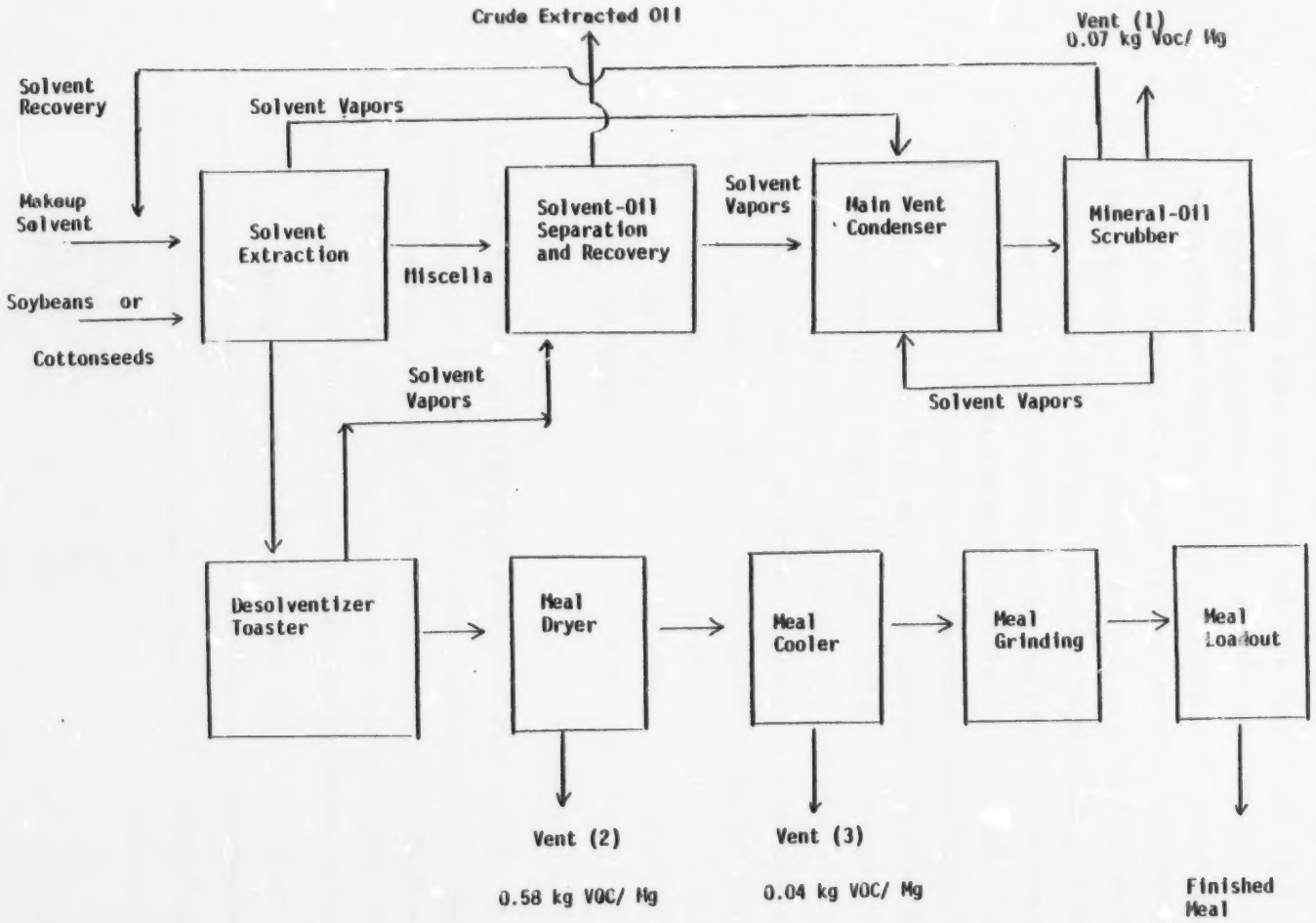


Figure 2-3. Model Plant Distribution of Emissions[6]

with solvent in process equipment) on the basis of soybean or cottonseed throughput, e.g., kg VOC/Mg soybeans or cottonseeds processed.

Fugitive loss sources include solvent storage, wastewater, conveyors, startups, shutdowns, and equipment leaks. Recent investigations by industry representatives indicate that as much as 64 percent of solvent loss occurs from mechanical sources (see Appendix C), including equipment leaks in the D-T, meal dryer, and meal cooler. Emissions also occur when the extraction process periodically shuts down for cleaning and maintenance.[6] Fugitive losses are estimated at 0.31 kg/megagram of soybeans or cottonseeds processed.[6] In general, it is difficult to quantify VOC emission sources, due to the difficulty of actually measuring hexane emission sources. Overall plant emissions are estimated on a daily basis from solvent replacement calculations, but individual sources have not been so readily quantified. This has hindered development of add-on control techniques for individual sources, since economic justification of a recovery technique for that source becomes difficult. The emissions listed in Figure 2-3 are only averages, and different plants may be significantly different in their emissions profile.

2.4 MODEL PLANT PARAMETERS

Two model plants were chosen to represent the range of typical soybean or cottonseed processing plants.[3,4] Figure 2-3 is a schematic diagram of a model plant with VOC emissions based on soybean throughput but emissions should be very similar for cottonseed plants.[3,4] Table 2-1 presents data on uncontrolled solvent losses for the two model plants.

Table 2-1. EMISSIONS FOR MODEL PLANTS (Kg/day)

Emission Source/Model Plant	A[a]	B[b]
Main vent (with MOS)	44	126
Meal dryer	363	1,035
Meal cooler	25	72
Fugitive losses[c]	195	558
Total	627	1,791

[a] Model Plant A has capacity of 630 Mg/day. References 4 and 6.

[b] Model Plant B has capacity of 1800 Mg/day. References 4 and 6.

[c] Fugitive losses include solvent storage, wastewater, conveyors, startups, shutdowns, and equipment leaks. References 4 and 6.

Additional literature sources have attributed the greatest proportion of solvent losses to equipment leaks, i.e., seals, packing glants, gaskets, etc. These sources indicate equipment leaks can account for as much as 65 percent of all solvent losses.[7] Appendix C presents solvent loss estimates from several additional sources.

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6. Draft Environmental Impact Statement. New Source Performance Standards for Soybean Processing Plants. Chapter 6. Model Plants and Regulatory Alternatives. U.S. Environmental Protection Agency, Research Triangle Park, N.C. March 28, 1980.

7. Myers, N.M., Solvent Recovery. Journal of American Oil Chemists' Society. Vol. 60, No. 2. p. 224. February 1983.

3.0 EMISSION CONTROL TECHNIQUES

This chapter discusses available control techniques that may be applicable to solvent extraction plants. As discussed in Chapter 2.0, the largest sources of VOC emissions are from three vent streams off the mineral oil scrubber, meal cooler, and meal dryer. Control of these emissions can be achieved through two approaches; good work practices and add-on control techniques.

3.1 WORK PRACTICES

The most viable approach to controlling emissions of VOC from solvent extraction processes is through good work practices. These include efficient operation of the mineral oil scrubber and desolventizer-toaster. Although, as noted previously, these pieces of plant equipment are in-place for processing purposes (minimize solvent loss); their efficient operation is necessary to minimize emissions of VOC. Efficient operating practices include ensuring solvent specifications, proper bean or seed preparation including drying, cleaning, cracking and dehulling, adequate extraction time and proper extraction operation (i.e., separating or drying the extracted solids as much as is feasible). Some plants utilize a condenser in front of the MOS system to increase the system efficiency. A well-operated MOS system can exceed efficiencies of 95 percent.[2] In addition, some plants also use carbon adsorbers as a back-up for the mineral oil system. The vent gas from the MOS is passed through a carbon adsorber for further solvent recovery. In general, though these systems can work quite well, it is more advantageous to install an oversized mineral oil scrubber, which operates more efficiently than a smaller MOS with a carbon adsorber.[2]

Additional emission reduction can be achieved through periodic maintenance inspection of equipment used to transfer potential VOC sources (organics). These include pumps, valves, agitators, pipes, etc. Any component suspected of operating improperly on the basis of sight, sound, or smell, should be repaired immediately. These repairs may include pump and pump seal replacement or repair, gasket replacement, and possible repair of valves and flanges used to transport organics. In addition to minimizing solvent loss through mechanical

sources, this maintenance program may decrease plant shutdowns, which is a major source of solvent loss. Table 3-1 presents emission factors for leaking and nonleaking components. Annual emission reductions from periodic inspection and maintenance would depend on the number of each type of component and the diligence of maintenance personnel in accomplishing repairs.

3.2 ADD-ON CONTROL EQUIPMENT

Two add-on control techniques have been studied to reduce vent stream emissions. These are thermal oxidation and carbon adsorption, discussed in subsections 3.2.1 and 3.2.2, respectively. However, according to the Research Triangle Institute, no VOC add-on control technique presently exists for solvent extraction process vent streams.[3]

3.2.1 Thermal Oxidation

Thermal oxidation systems are available that would reduce hexane emissions from processing plants including direct thermal incineration and catalytic oxidation.[3] For catalytic oxidation, the vent streams from the cooler and dryer may contain particulates which would significantly decrease the effectiveness of this technique. For thermal incineration, supplemental fuel would be required to sustain combustion of the emissions from the dryer and cooler. In any event, the costs associated with either system prohibit recommendation of incineration techniques.[3]

3.2.2 Carbon Adsorption

The typical activated carbon adsorber unit will have two adsorption beds. One bed is used to control emissions while the other bed is being regenerated. This technique utilizes the ability of carbon to preferentially adsorb and concentrate organic components contained in gaseous streams. The gas phase containing the organics is pumped through a fixed, activated carbon bed, where the organics are captured on the carbon surface by intermolecular or Van-der-Waals forces. The ability of the carbon to adsorb organics depends mainly on concentration, temperature (below 100°F), and molecular size. The efficiency of this technique is also dependent on particulates which may damage the bed.

Table 3-1. LEAKING EQUIPMENT EMISSION FACTORS

Component/Service	Emission Factors[a] leaker (kg/hr)	Emission Factors[a] non-leaker (kg/hr)	Emission Reduction for Successful Repair (kg/hr)
Pump seals: light liquid	0.437	0.012	0.425
Valves: light liquid	0.0852	0.0017	0.0835
Pressure relief valves: Gas	1.691	0.047	1.644
Open-ended valves: all	0.01195	0.0015	0.0104
Flanges: all	0.0376	0.00006	0.0374

[a] Reference 1.

Carbon adsorption has several drawbacks in this application. Along with high costs, potential fire hazard and explosion have made this technique, like thermal incineration, unattractive to industry.

3.3 REFERENCES

1. Fugitive Emission Sources of Organic Compounds -- Additional Information on Emissions, Emission Reductions, and Costs. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Research Triangle Park, N.C. EPA-450/3-82-010. April 1982.

2. Myers, N.M., Solvent Recovery. Journal of American Oil Chemists' Society, Vol. 60, No. 2. p. 224. February 1983.

3. Summary of Technical Information for Selected Volatile Organic Compound Source Categories. U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA 450/3-81-007. May 1981.

4.0 ENVIRONMENTAL ANALYSIS OF RACT

This chapter discusses the environmental impacts of RACT that would result from implementing reasonably available control technology (RACT). In general, the primary emphasis is a quantitative assessment of VOC emissions in the absence of RACT (baseline emissions), and after the implementation of RACT.

4.1 REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT)

RACT for the soybean and cottonseed processing industry is a limitation of 2.6 kg of solvent loss per megagram of conventional soybean crush and 5.2 kg of solvent loss per megagram of specialty soybean crush. RACT comports with the limitation proposed by the Illinois Environmental Protection Agency and the National Soybean Processing Association.[1] Since variations in day-to-day production can have a significant effect on VOC loss, the limitation is determined on a 180 calendar day basis. This limit is considered well within capabilities if determined on a rolling basis (180 calendar days) and if the MOS system and desolventizer-toaster operate efficiently as discussed in Chapter 3.0. Table 4-1 gives the emission rates for the proposed Illinois EPA RACT limitations for conventional plants. The ability of cottonseed processing plants to achieve and maintain this limit is expected to be very similar to extraction plants processing soybean based on conversations with industry representatives.[2,3]

Table 4-1. EMISSIONS RATES FOR MODEL PLANTS[a]

Model Plant	Throughput, Mg Soybean crush/day	RACT Emissions kg/day
A	630	1,638
B	1,800	4,680

[a]Reference 4.

RACT practices also include a visual leak detection and repair program for equipment handling or contacting VOC (hexane). This program

would include weekly inspections of pumps and repair of any piece of equipment found leaking to be done as soon as practicable, but within 15 days of detection.

4.2 AIR POLLUTION

One of the solvent extraction plants currently operating in Shelby County, Tennessee, is below the proposed Illinois regulation. For this plant, the RACT limitation will not have any impact on air pollution. The impact of the second plant presently exceeding the RACT limitation will result in a reduction of VOC emissions. Quantification of the emission reduction achieved through implementation of RACT is not possible because present solvent usage is held in confidence.

4.3 WATER POLLUTION

The implementation of RACT is expected to have minimal impact on water pollution. The efficient operation of the MOS system and desolventizer-toaster may have a slight positive impact on water pollution since potential hexane emissions will be reduced. Repair of leaking equipment may reduce the amount of organics entering plant wastewater systems.

4.4 SOLID WASTE

The implementation of RACT will not have an impact on solid waste.

4.5 ENERGY IMPACTS

No appreciable change in energy is expected to occur through implementation of RACT.

4.6 REFERENCES

1. National Soybean Processors Association. Comments on Volatile Organic Material Emissions from Stationary Sources: RACT III. Regulation of Hexane Extraction Soybean Crushing Plants. April 5, 1984.

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4. Draft Environmental Impact Statement, New Source Performance Standards for Soybean Processing Plants, Chapter 6. Model Plants and Regulatory Alternatives. U.S. Environmental Protection Agency, Research Triangle Park, N.C. March 28, 1980.

5.0 CONTROL COSTS ANALYSIS OF RACT

5.1 COST SUMMARY

It is not possible to discern costs of efficient operation of the mineral oil scrubber and desolventizer-toaster as they relate to emission reduction. These processes are so integrated into the total operation, that it is difficult to differentiate between the price of a unit, its installation, or operational costs.[1] Therefore, a cost analysis encompassing capital costs, annualized costs, and product recovery credit (if any) was not performed.

According to a representative of the Environmental Protection Agency, the cost of a thermal incineration unit on the main vent in 1980 dollars is $69,500 and $101,200 on the meal dryer vent and about $90,000 and $132,000 in October 1984 dollars, respectively.[2] However, hexane revenues are not realized until the hexane content exceeds 9 Mg per day. This makes any economic justification very difficult.

Carbon adsorption is not considered an alternative control choice since the possibility of bed fires is present. No cost analysis is performed on this unit.

Costs for visual monitoring of equipment (e.g., pumps, valves) are presently incurred by solvent extraction plants. During routine daily operations, plant personnel work in close proximity to most equipment. Therefore, implementing weekly visual inspections for pumps would not require any additional labor. Additional costs, however, would be incurred to repair leaking equipment by way of maintenance labor and replacement parts (e.g., valve or pump seal packing). These costs would be offset by the credit associated with preventing continued loss of hexane from leaking equipment. Also, repair of leaking equipment should be performed as part of good engineering practices to reduce the safety hazards associated with equipment leaking hexane. Therefore, no additional costs are assumed for implementing RACT for equipment leaks in solvent extraction plants.

5.2 REFERENCES

1. Summary of Technical Information for Selected Volatile Organic Compound Source Categories, U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA 400/3-81-007. May 1981.

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APPENDIX A

MODEL REGULATION

APPENDIX A MODEL REGULATION

1200-3-18-____ SOLVENT EXTRACTION PLANTS

(1) For the purpose of this rule, the following definitions apply:

(a) "Equipment" means each pump, valve, pressure relief valve, sampling connection, open-ended valve, and flange or connector in VOC service.

(b) "In-VOC service" means that the piece of equipment contains or contacts at least 10 percent by weight VOC.

(c) "Repaired" means that equipment is adjusted or otherwise altered in order to eliminate indications of a leak.

(d) "Solvent extraction plant" means any facility engaged in the use of hexane or other VOC substance in the process of extracting oils from soybean or cottonseed flakes.

(e) "Conventional plant" means any facility engaged in extracting meal for ultimate non-human consumption.

(f) "Specialty plant" means any facility engaged in extracting meal for ultimate human consumption.

(g) "Calendar day" means consecutive days.

(2) The owner or operator of a solvent extraction plant, which would emit volatile organic material in excess of 100 tons per year in the absence of pollution control equipment or enforceable operating permit limitation, shall not cause or allow emissions to exceed:

(a) 0.0026 lbs of volatile organic compounds per pound of conventional soybean or cottonseed crush, and

(b) 0.0052 lbs of volatile organic compounds per pound of specialty soybean crush.

These limitations are to be calculated on a 180 calendar day basis.

(3) The owner or operator of a solvent extraction plant shall be subject to the following requirements:

(a) Each pump shall be checked by visual inspection each calendar week for indications of liquids dripping from the pump seal. If there are indications of liquids dripping from the pump seal, it shall be repaired as soon as practicable, but no later than 15 calendar days after it is detected.

(b) If any equipment in VOC service appears to be leaking on the basis of sight, smell, or sound, the following requirements shall apply:

1. A readily visible identification, in the form of a weather-proof tag, shall be attached to the leaking equipment. The identification may be removed upon repair.
2. The leaking equipment shall be repaired with an initial attempt as soon as practicable, but no later than 15 calendar days after it is detected.
3. When a leak is detected, the owner or operator shall record the date of detection and the date of repair. The log recording leak detection and repair shall be maintained for 2 years at the facility in a readily accessible location.

B.0 ENFORCEMENT ASPECTS

The model regulations for solvent extraction plants require a volatile organic compound (VOC) limit of 2.6 kg VOC/Mg meal crushed for conventional plants and 5.2 kg VOC/Mg meal crushed for specialty plants. These limitations are to be met based on (1) efficient operation of the mineral oil system and desolventizer-toaster and (2) an inspection and maintenance program to minimize VOC losses from mechanical sources. These requirements rely on visual inspections and on records maintained by the source to monitor compliance. Factors important to assessing compliance with the regulations are discussed below.

B.1 SOLVENT LOSS CALCULATIONS

The recommended requirements for solvent loss are to be calculated on a 180-calendar-day basis as follows: 1) review plant operating records and sum the total kg of solvent bought for the past 180-calendar days; 2) review plant operating records and sum the total Mg meal crushed for the past 180 calendar days; 3) divide total kg solvent used by the total Mg meal crushed to determine the ratio of solvent purchased to meal crushed.

B.2 INSPECTION OF MAINTENANCE PROGRAM

In addition to reviewing solvent loss calculations, compliance of RACT can be determined by periodic plant inspection and review of plant equipment maintenance records. The observed presence of a significant number of leaking components and, upon review of maintenance records, evidence of continually delayed repair (frequently exceeding 15 calendar days), would indicate that good housekeeping practices are not in order.

To enable determination of compliance, plant maintenance records should include the dates on which: (1) leaks are initially detected, (2) an initial attempt at repair was made; and (3) successful repair is accomplished. Each equipment component should be identified in such a manner as to allow enforcement personnel to readily locate and cross-reference equipment in the plant with recorded leak repair information.

To facilitate plant inspections, plant owners or operators must be able to produce plant records upon request.

APPENDIX C

SOLVENT LOSS ESTIMATIONS

C.1 SOLVENT LOSS DATA

This appendix presents recently published data on solvent losses from solvent extraction plants. Recent industry studies indicate that up to 92 percent of solvent loss originates from two sources: (1) the desolventizer-toaster and (2) mechanical losses.[1] Losses from the desolventizer-toaster may appear in the extracted meal, the meal dryer vent, or the meal cooler vent. Generally, the bulk of these losses occurs in the two process vents. Mechanical sources can include pumps, valves, flanges, vessel gaskets or seals, etc., and one study indicates this source may be responsible for as much as 64 percent of all plant solvent losses. Industry studies generally agree on the approximate amount of plant-wide solvent losses, but differ in the amount of losses attributed to individual sources. Data presented in recent publications on solvent losses are summarized in tables C-1 and C-2. Table C-1 presents results from a study performed on a soybean extraction plant and Table C-2 gives the results for a rapeseed extraction investigation. Table C-1 shows that a better than average plant, which is about 40 percent more efficient than an average plant, has 1.38 kg solvent loss per megagram soybeans crushed, while the average plant has 1.93 kg solvent loss for every megagram of soybeans crushed. Table C-2 indicates a typical rapeseed plant may operate with very low solvent losses per megagram rapeseed crushed. The studies assume the extraction plants remain in continuous operation and use a mineral oil system to recover hexane. The soybean extraction plant has a capacity of 900 Mg/day (1,000 tons/day), while the rapeseed study did not reference plant capacity.

C.2 CONCLUSIONS

Both studies indicate that a well operated and efficient extraction plant should be able to meet the limit of 2.6 kg solvent loss per megagram crush for solvent extraction plants operating in Shelby County, Tennessee.

TABLE C-1. SOLVENT LOSS SOURCES FOR A SOYBEAN PLANT[a]

Source	Better than average plant[c] (kg/Mg)	Average Plant[d] (kg/Mg)
DT meal	0.391	0.782
Oil	0.096	0.193
MOS vent gas[b]	0.003	0.014
Mechanical[c]	0.887	0.939
TOTAL	1.38	1.93

[a] Reference 1.

[b] Mineral oil scrubber (MOS) vent gas is 200 ft^3/min.

[c] Mechanical losses include pumps, valves, flanges, conveyors, solvent storage, and wastewater.

[d] Both plants are assumed to be in continuous operation with the better than average plant being approximately 40 percent more efficient than the average plant.

TABLE C-2. SOLVENT LOSS FOR TYPICAL RAPESEED PLANT[a]

Source	Solvent loss (kg/Mg)
DT meal	1.031
Oil	0.046
Dryer/Cooler vent gas	0.198
MOS vent gas	0.040
Waste Water	0.007
TOTAL	1.32

[a] Reference 2.

C-1. REFERENCES

1. N.M. Myers. Solvent Recovery. Journal of American Oil Chemists' Society. Vol. 60, No. 2. February 1983.

2. J.A.H. Dahlen and L.A. Lindh. Mass Balance of Hexane Losses in an Extraction Plant. Journal of American Oil Chemists' Society. Vol. 60, No. 12. December 1983.